DIGITAL IMAGING

Summary

Government agencies increasingly look towards digital imaging to enhance productivity and to provide greater access to certain types of information. Digital imaging offers many advantages, including: improved distribution and publication, increased access, streamlined workflows, and a greatly reduced need for physical storage space. In addition, digital images can be used to create text-searchable files through the application of optical character recognition (OCR) software. They can be made available over the World Wide Web, allowing government agencies and businesses to provide information to business partners or the general public quickly and efficiently.

While digital imaging is becoming increasingly popular and commonplace, you must remember it is an investment with potentially very high up-front costs. Continuing investments in all aspects of an imaging application are also required on a routine and frequent basis. Digital imaging should make financial sense for your agency. To assure your digitized records are fully admissible in court, they must be trustworthy, complete, and durable for as long as your approved records retention schedules require.

The Archives recommends the use of the following guidelines for the design, selection, and operation of digital imaging records systems. These guidelines will help you produce records and copies acceptable in legal proceedings; they will enable you to maintain and retrieve information in ways to meet your statutory obligations and operational needs; and they will help you respond to requests from the public. These considerations are important, especially for long-term or permanent records.

Legal Framework

For more information on the legal framework you must consider when developing a digital imaging system, refer to the chapter *Records Management in an Electronic Environment* in the Electronic Records Management Guidelines and Appendix A6 of the *Trustworthy Information Systems Handbook*. Also review the requirements of the:

- South Carolina Public Records Act [PRA] (*Code of Laws of South Carolina, 1976*, Section 30-1-10 through 30-1-140, as amended) available at www.scstatehouse.org/code/t30c001.htm, which supports government accountability by mandating the use of retention schedules to manage records of South Carolina public entities. This law governs the management of all records created by agencies or entities supported in whole or in part by public funds in South Carolina. Section 30-1-70 establishes your responsibility to protect the records you create and to make them available for easy use. The act does not discriminate between media types. Therefore, records created or formatted electronically are covered under the act.
- South Carolina Uniform Electronic Transactions Act [UETA] (*Code of Laws of South Carolina, 1976*, Section 26-6-10 through 26-6-210). Enacted in 2004, UETA facilitates electronic commerce and electronic government services by legally placing electronic records and signatures on equal footing with their paper counterparts. UETA officially repeals the 1998 South Carolina Electronic Commerce Act (*Code of Laws of South Carolina, 1976*, Section 26-5-310 through 26-5-370). The purpose of UETA is to establish policy relating to the use of electronic communications and records in contractual transactions. This law does not require the use of electronic records and signatures but allows for them where agreed upon by all involved parties. While technology neutral, the law stipulates that all such records and signatures must remain trustworthy and accessible for later reference as required by law. Similarly, the federal Electronic Signatures in Global and National Commerce (E-Sign) Act [U.S. Public Law 106-229] encourages the use of electronic documents and signatures, although it goes further to provide some guidelines regarding standards and formats. For more information on UETA see Appendices A6 and A7 of the *Trustworthy Information Systems Handbook*.

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- Uniform Photographic Copies of Business and Public Records as Evidence Act (*Code of Laws of South Carolina, 1976*,Section 19-5-610) available at scstatehouse.org/code/t19c005.htm, which establishes that an accurate reproduction of a record is as admissible in evidence as the original in any judicial or administrative proceeding. It further stipulates that if an accurate and durable reproduction is made, the original record may be destroyed in the regular course of business unless its preservation is required by law.
- Health Insurance Portability & Accountability Act of 1996 [HIPAA] (Public Law 104-191), which establishes security and privacy standards for health information. The Act protects the confidentiality and integrity of "individually identifiable health information," past, present or future. Visit the South Carolina HIPAA website at www.hipaa.state.sc.us/ for additional information.

Records Retention Schedules

To ensure the acceptance of government records as legal documents — including those stored in digital imaging records systems — they should be maintained and disposed of as part of a legally-acceptable records management program. To conduct such a program you should include every record on records retention schedules that describe each record adequately and define its retention period and disposition. These schedules must be approved by the Archives. For more information on records schedules see the guideline *Records Management in an Electronic Environment*.

Retention of Digital Images and Originals

- Depending on the length of time required for retention you will need to decide which format best maintains your original and digitized records. Generally, maintaining records only in a digital format is not recommended for series with an established retention of more than ten years. In these instances, long-term preservation formats including paper and microfilm should be considered. See the SCDAH *Information Leaflet #13,* "Public Records Stored as Digital Images," www.state.sc.us/scdah/techlflt.htm#leaflets for the complete policy on the retention and disposition.

Imaging Terms

Digital imaging is a process by which a document or photo is scanned by computer and converted from analog format to a computer-readable digital format. After scanning, the original document or photo can be represented by a series of pixels arranged in a two-dimensional matrix called a bitmap (raster) image or in a three dimensional vector image. This image can then be transferred onto a variety of electronic storage media, such as CD-ROM, for storage and use.

For a better understanding of imaging you should be familiar with the following terms:

- **Pixel Bit Depth:** Defines the number of shades that can actually be represented by the amount of information saved for each pixel. These can range from 1 bit/pixel for binary (fax type) images to 24 bits per pixel or greater in high quality color images. The following are current standard bit depths for image files:

Table 1: Standard pixel bit-depths

Bit-depth	Displays	Recommended for
1-bit or "bi-tonal"	black and white	Typewritten documents
8-bit grayscale	256 shades of gray	Black and white photographs, half-tone illustrations, handwriting
24-bit color	Approximately 16 million colors	Color graphics and text, color photographs, art, drawings, maps

Information taken from: *Technical Recommendations for Digital Imaging Projects* (Columbia University Libraries, April 1997), pages 4-5. www.columbia.edu/acis/dl/imagespec.html

- **Resolution:** The quality of a digital image is dependent on the initial scanning resolution. Resolution is expressed in the number of dots, or pixels, used to represent an image, expressed commonly as "dpi," dots per inch. You may also see "ppi" (pixels per inch) and "lpi" (lines per inch) used. As the dpi value increases, image quality increases but so does the file size.

  Unlike paper documents, the resolution of photographs is sometimes expressed in the number of pixels across the long-dimension of an image. When creating standard-sized images from photographs or negatives of differing sizes (e.g., 35mm, 4"x 5"), the scanning resolution in dpi varies. In such cases, it is often easier to measure resolution as the number of pixels across an image's long dimension. For example, each of the

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following files measures 3000 pixels in the long-dimension, although they have varying values of dpi.

Table 2: Resolution as the number of pixels across the long-dimension of an image

Original photo size	Digital image size	Scanning resolution
8"x10"	2400 x 3000 pixels	300dpi
4"x5"	2400 x 3000 pixels	600dpi
35mm negative	2400 x 3000 pixels	2100dpi

Information taken from: Maxine K. Sitts, *Handbook for Digital Projects: A Management Tool for Preservation and Access* (Andover, Massachusetts: Northeast Document Conservation Center, 2000), page 86.

To determine needed scanning resolution, you must first establish the desired quality of your images and the storage capacity of your computer system. You will also need to consider the desired speed of delivery of the images, especially if they will be accessed over the Internet. You may want to scan high-resolution masters of your images and then create lower resolution copies for web delivery. General recommendations for master files are as follows:

Table 3: Recommended scanning resolutions for master files

Material	Recommended resolution (8-bit grayscale and 24-bit color)
Textual records, maps and oversize	300 dpi
Photographs, negatives, slides	300-600 dpi
Prints, paintings, drawings	600 dpi

- **Compression:** Data compression saves file space. There are two types of compression, lossless and lossy. Under lossless compression no data is lost (although the file is still compressed). Under lossy compression data is lost. Lossy compression attempts to eliminate redundant or unnecessary information. Depending upon the degree of compression, this information loss may be unnoticeable to the human eye. For example, it is possible for a JPEG file (a lossy compression) and a TIFF file (lossless) to appear exactly the same, although the JPEG file is missing data, making it significantly smaller. These file formats, and others, are discussed in the following section.

File Formats

In any digital imaging project, choosing the file formats you will use is important. The file format directly affects the quality and file size of your images. Choosing the best file format for your needs requires knowing how your images will be used (e.g., archival or display functions), the type of materials you will be imaging (e.g., text, art, graphics, photos), and the desired speed of delivery and the necessary quality of your images.

For many digital imaging projects it is necessary to create master images. Master images are especially necessary when creating a digital archive. They will serve as archival copies and be the basis from which derivative images are subsequently created. For this reason, high quality is crucial; master images must be in a high resolution and lossless format, insuring that the original document is captured as completely as possible. Master images are high quality images, and they facilitate such functions as implementing OCR, verifying textual information, or zooming into details in maps or photographs. The TIFF file format, which allows high resolution and utilizes lossless compression, is well suited for making master images.

Master images, in formats such as TIFF, have large file sizes, making their delivery cumbersome for some web and document management system applications. To enhance the speed of delivery, you can create derivative images from the master images. Derivative images have smaller file sizes, are of lower quality, and typically use a lossy compression. The JPEG file format is commonly used for derivative images.

Common types of digital image file formats include:

- *Tagged Image File Format* (TIFF) files, which are widely usable in many different software programs. TIFF files utilize lossless compression and are commonly used for master copies. TIFF graphics can be any resolution, and they can be black and white, grayscale, or color. TIFF is a very extensible format, allowing variations to be created for specific applications. Variations include GeoTIFF, used in cartographic and GIS (geographic information system) applications; TIFF Class F, used in faxing applications; and TIFF/IT, used in the graphic arts industry. Files in TIFF format end with a .tif extension.
- *Graphics Interchange Format* (GIF) files. GIF supports color and grayscale. Limited to 256 colors, GIFs are more effective for images such as logos and graphics rather than color photos or art. It should be noted that although the GIF format is widely used, it is technically

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proprietary. GIF is a lossless compression. Files in GIF format end with a .gif extension.

- *Joint Photographic Experts Group* (JPEG) files. JPEG is a lossy compression technique for color and grayscale images. Depending upon the degree of compression, the loss of detail may or may not be visible to the human eye. Files in JPEG format end with a .jpg extension.
- *Bitmap* (BMP) files. BMP files are relatively low quality and used most often in word processing applications. BMP format creates a lossless compression. Files end with a .bmp extension.
- *Portable Network Graphics* (PNG) files. A lossless compression designed to replace GIF files, PNG files can be ten to thirty percent more compressed than GIFs. PNG is completely patent and license free and is of higher quality than GIF. Files in PNG format end with a .png extension.
- *Portable Document Format* (PDF) files. PDFs are useful for viewing and printing multiple documents and images. Commonly used to capture, distribute, and store electronic documents, PDF preserves the fonts, images, graphics, and overall "look" of the original digital files. As with the GIF format, the PDF format is proprietary, although widely used. Files saved in PDF format end with a .pdf extension.

For a more in-depth discussion of file formats, refer to the File Formats guidelines.

Image Storage

Digital images are stored on digital media. Digital media are divided into two main types — magnetic and optical.

Magnetic media include:

- *Magnetic disk*. Magnetic disks include the hard disk found in your computer that stores the programs and files you work with daily. Magnetic disks provide random access. Also included are removable hard disks, floppy disks, zip disks, and removable cartridges.
- *Magnetic tape*. Magnetic tapes come in reel-to-reel as well as cartridge format (encased in a housing for ease of use). The two main advantages of magnetic tapes are their relatively low cost and their large storage capacities (up to several gigabytes). Magnetic tapes provide sequential access to stored information, which is slower than the random access of magnetic disks. Magnetic tapes are a common choice for long-term storage or the transport of large volumes of information.
  - — *Digital Linear Tape* (DLT). DLTs are in a cartridge format a little larger than a credit card. Data is compressed using a special compression algorithm. DLT provides sequential access at high speeds.
  - — *Linear Tape-Open* (LTO). Linear Tape Open is an open standard magnetic tape system. Similar to DLT in capacity and speed, LTO's standardized format allows interoperability between tapes and tape drives made by different manufacturers.

Optical media include:

- *Compact Disk* (CD). Compact disks come in a variety of formats. These formats include CD-ROMs that are read-only, CD-Rs that you can write to once and are then read-only, and CD-RWs that you can write to in multiple sessions.
- *Write-Once, Read-Many* (WORM) disk. WORM disks require a specific WORM disk drive to enable the user to write or read the disk. WORM disks function the same as CD-R disks.
- *Erasable Optical* (EO) disk. The user can write to, read from, and erase from EO disks as often as they can magnetic disks. EO disks require special hardware.
- *Digital Versatile Disk* (DVD). DVD disks are optical disks with more storage capacity than CD-ROMs. Common types of DVDs include DVD-ROM, DVD-RAM, DVD-R, DVD+R, DVD-RW, DVD+RW

Because DVD technologies are undergoing rapid development, DVDs created using one type of equipment might not be viewable on all systems. DVD is an attractive format due to its high storage capacity; however, due to the lack of a single standard for this technology it is advisable to consider other options, especially for vital records and records requiring long term storage. Recommended alternatives to DVD for digital storage include magnetic tape and CD.

Other storage options include:

- *Microfilm*. Microfilm comes in a variety of widths (16mm, 35mm and 105mm) and types (silver gelatin, diazo, vesicular, electrophotographic and dry silver). With an potential life span of 500 years, silver gelatin microfilm is recommended for long-term or permanent images. To learn more

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about storing digital images on microfilm see SCDAH *Information Leaflet #27*, "Guidelines for the Conversion of Digital Images to Microfilm Format."

- For digital storage, it is highly recommended that you store digital images on CD-R or WORM to assure that the stored records are tamper-proof, allowing the greatest security for the data. If using DVD for short term storage, DVD-R disks are preferable to other DVD formats. Rewritable disks (DVD-RW, DVD+RW), in contrast, are designed to be re-used, making data integrity uncertain.

Due to the limited life expectancy of digital media, no digital storage medium is adequate for the long-term or archival preservation of records. The most generous estimate of physical obsolescence is thirty years. Technological obsolescence, though, will probably come within five to ten years. As a result, you should assume the need to migrate all your files to a new storage medium on a regular basis. In the meantime, you will need to protect your stored data with a comprehensive back-up system. Microfilm is a time-tested alternative to migrating digitally imaged records. Making microfilm copies is advisable for long-term or archival records.

For more information on digital storage media, refer to the *Digital Media* guidelines.

Metadata

Metadata can be simply defined as "data about data." More specifically, metadata consists of a standardized structured format and controlled vocabulary which allow for the precise description of record content, location, and value. Metadata often includes items like file type, file name, creator name, date of creation, and the record's classification.

Metadata are crucial to any digital imaging project, enabling proper data creation, storage, retrieval, use, modification, and retention of your digitized records. In addition, proper metadata help document the trustworthiness of your system, assuring the legal admissibility of your digitized records in court.

For digital images, metadata are especially important in facilitating retrieval. Unless you plan to use OCR, all of your records will be stored as graphic files. The only way to locate specific information will be through its metadata. Metadata make it possible to locate, use, and evaluate information through standard search criteria such as subject heading, numerical identifier, or keyword. For this to work effectively, you will have to identify the metadata your employees or patrons use to search for records.

For more information concerning metadata, refer to the *Criteria Group 5* in the *South Carolina Trustworthy Information Systems Handbook* guidelines.

Justifying the Cost

Digital imaging should make financial sense for your agency. While digital imaging is becoming increasingly popular and commonplace, you must remember it is an investment with potentially very high up-front costs. You also need to keep in mind that, because of the rapid pace of technological obsolescence, you will need to make continuing investments in all aspects of an imaging application on a routine and frequent basis. Due to the expense associated with imaging, justifying an imaging system based only on potential cost savings is not recommended.

Is digital imaging financially right for you? A comprehensive cost-benefit analysis is a necessary step in determining the answer. Costs will include system hardware, system software, application software, long-term system maintenance, staff training, vendor costs, and other expenses. Benefits include better customer service, higher office productivity, lower storage costs, and the option of using the Web to make digitized information easily accessible.

Choosing a Vendor

Most agencies do not have the appropriate scanning equipment, software, or staff expertise to execute a large digitizing project. For this reason, vendors have become integral to the world of digital imaging. Quality varies among vendors, so selecting the right one is crucial to your project.

Vendors provide digitizing services, technical advice, and sometimes the long-term maintenance of the resulting electronic files. To better choose your vendor, you should become familiar with digitizing technology and the terms used by the industry. You must also have a clear idea of your project and its goals. Questions such as the following must be addressed:

- How much material will be digitized?
- What type of materials will be digitized? Textual documents? Photographs? Maps?

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- Who is the intended audience? Staff members? Researchers? The general public?
- What is the required quality of the digital images? High or low resolution? Black and white or color?
- What is the desired end product? A document management system? A searchable online collection?

As technology products and vendors come and go, you should assume and plan for the possibility of vendor business failure and the inevitability of product obsolescence. The best way to protect yourself is to insist on an open systems architecture, using non-proprietary hardware and software. Non-proprietary means that the chosen hardware and software is not specific to that vendor. If proprietary software is unavoidable, it should be licensed beyond the length of the contract. As there will inevitably be some bugs in the system, a contract should completely spell out the provisions for implementation, service, upgrades, and repair.

Implementation Strategy

To successfully implement a digitizing project in a timely manner, you must create an implementation strategy which manages workflow. A digitizing project incorporates a myriad of tasks, the successful management of which can save time and money. While a vendor may be contracted for the project, you will still need to manage an assortment of activities, including the:

- Selection of materials to be digitized
- Preparation of materials, including sorting files, removing staples and paperclips, weeding out unnecessary materials, and conservation of any deteriorating documents.
- Creation of standardized metadata
- Quality control of source materials and digital images
- Staff training on new hardware and/or software
- Advertising, promotion, and user evaluation
- Long-term maintenance of resulting electronic files

Your implementation strategy may include setting up a pilot project. A pilot project will allow you to test the technology, examine the effectiveness of your digital images in providing and managing information for patrons or employees, and help determine how you can better implement a digital imaging system. A pilot project is especially necessary to study the impact and effectiveness of imaging before undergoing a large digitizing project for a whole department or organization.

Phases are an effective approach to implementing large digitizing projects. Rolling out the system in phases enforces an organized and careful approach to implementation. This allows small errors to be caught and corrected before they snowball into large and costly issues. Phases can be applied in several ways depending upon the structure of your organization and scope of your project. For example, you may want to phase in the system by departments or by function. If your project will be implemented over a lengthy time period, you may want to phase in your system beginning with your organization's highest priorities.

Suggestions for better digital imaging projects

Planning

- Conduct a cost-benefit analysis to determine the cost justification of a system purchase and to determine the possible benefits to the agency with its implementation. Get upper management support. Your cost benefit analysis must include an annual expense of fifteen to twenty percent of the purchase price for training, upgrades, maintenance, and storage.
- Conduct a records and workflow analysis to determine and document existing and planned agency information needs
- Provide specific plans for an ongoing process of migrating long-term and archival records from older to newer hardware and software platforms.
- Assign a permanent staff member as systems administrator and require the vendor to provide a project director during the installation and training periods.

Choosing equipment and software

- When determining document scanning resolution, consider data storage requirements, document scanning throughput rates, and the accurate reproduction of the image. Select systems that provide enough scanning resolution to produce a high-quality image that is at least as legible as the original record. Validate the quality of the image by testing with actual documents.
- Use an indexing database that provides for efficient retrieval, ease of use, and up-to-date information about the digital images stored in the system. Incorporate metadata to facilitate records management.

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- Seek vendors who use standard rather than proprietary compression algorithms and file headers to make migrations of data more certain and reliable. If vendors use proprietary algorithms, they must be able to demonstrate their capacity to bridge to standard compressions and file headers.

Implementation

- Establish operational practices and provide technical and administrative documentation to ensure the future usability of the system, continued access to long-term records, and a sound foundation for assuring the system's legal integrity. Documentation should include information on hardware and software, including brand names, version numbers, dates of installation, upgrades, replacements, and conversions; operating procedures, including methods for scanning or entering data; revising, updating, indexing, backing up; testing the readability of records; applying safeguards to prevent tampering and unauthorized access to protected information; and carrying out the disposition of original records.
- Determine which records you want to capture and manage digitally and if back-file records will be included. Review general and agency specific retention and disposal schedules, and dispose of documents that the agency is not required to retain.
- Determine if the records are adequately organized. Make certain that the records were properly filed and correct all mis-filings before imaging.
- Digitize in phases, beginning with the most highly used records first.
- Institute procedures to ensure quality and integrity of scanned images. Include visual inspection in your operational procedures to verify the completeness and accuracy of the scanning process both in the initial digitization process to magnetic media and when the image is converted to the records storage medium.
- Incorporate retention and disposal of electronic images and electronic records into agency retention schedules.
- Use non-rewritable recording media to preserve record integrity. Provide adequate environmental conditions for digital storage media. Label digital media, tapes, and other storage containers with particular care since it is impossible to determine content merely by looking at the storage medium.
- To retrieve information in records that will be held for many years, you must develop and document indexes with both today's and tomorrow's users in mind. Design backup procedures to create security copies of digitized images and their related index records.
- Verify that a disaster preparedness plan is in place to facilitate image and data backup, storage and recovery. For more information on disaster preparedness see the *Trustworthy Information Systems Handbook* and the SCDAH *Information Leaflet #16*, "Disaster Preparedness and Recovery in State and Local Government Records Offices."
- Annually sample 3% of both the working and security copies of the digital records and indexes to make sure the data are still readable. Prepare an appropriate plan for "refreshing" data and migrating and converting images and corollary indexes to new storage media as needed. When the retention period for records in digital image media exceeds ten years, the Department of Archives and History strongly recommends their maintenance in eye-readable form for additional security. For more information on long and short term digital imaging policy see the SCDAH *Information Leaflet #13*, "Public Records Stored as Digital Images."

Annotated List of Resources

Primary Resources

California Digital Library. *California Digital Library Digital Format Standards*. July 2001. www.cdlib.org/about/publications/CDLImageStd-2001.pdf

These standards, published by the California Digital Library at the University of California, provide recommendations for image quality, file formats, and storage media for digital image collections.

Columbia University Libraries. *Technical Recommendations for Digital Imaging Projects*. April, 1997. www.columbia.edu/acis/dl/imagespec.html

These digital imaging recommendations were prepared by the Image Quality Working Group of ArchivesCom, a joint committee between Columbia University Libraries and AcIS (Academic Information Systems at Columbia University. Provides recommendations for image quality, file formats, and other capture and storage issues.

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Sitts, Maxine K. *Handbook for Digital Projects: A Management Tool for Preservation and Access*. Andover, Massachusetts: Northeast Document Conservation Center, 2000.
www.nedcc.org/digital/dighome.htm

This handbook, published by the Northeast Document Conservation Center, is geared towards librarians, archivists, and other cultural or natural resource managers. Provides a basic technical overview of digital imaging and emphasizes project management, cost justification, vendor relations, and related issues.

South Carolina Department of Archives and History. *Information Leaflet #13: Public Records Stored as Digital Images*. 2003.
www.state.sc.us/scdah/techlflt.htm#leaflets

This leaflet provides policy information on imaging public records in South Carolina.

Additional Resources

Colorado Digitization Project
www.cdpheritage.org/

A collaborative effort among Colorado's archives, historical societies, libraries, and museums, the Colorado Digitization Project aims to create a statewide digital library. The website features technical guidelines, digitizing standards, a digital imaging glossary, and links to many additional resources.

Cornell University, Department of Conservation and Preservation. *Moving Theory Into Practice: Digital Imaging Tutorial.*
www.library.cornell.edu/preservation/tutorial/

Produced by the Digital Imaging and Preservation Policy Research (DIPPR) team at Cornell University's Department of Conservation and Preservation, this web tutorial provides an overview of technical and project management issues regarding digital imaging. The tutorial uses examples of actual digital images to demonstrate variations in image quality.

South Carolina Department of Archives and History. *Trustworthy Information Systems Handbook*. Version 1, July 2004.
www.state.sc.us/scdah/erg/tis.htm

This handbook provides an overview for all stakeholders involved in government electronic records management. Topics center around ensuring accountability to elected officials and citizens by developing systems that create reliable and authentic information and records. The handbook outlines the characteristics that define trustworthy information, offers a methodology for ensuring trustworthiness, and provides a series of worksheets and tools for evaluating and refining system design and documentation.

Newcombe, Tod. *The Local Government Guide to Imaging Systems: Planning and Implementation*. United States: Public Technology, Inc., 1995.

A publication by Public Technology, Inc. (PTI) and the International City/County Managemnt Association (ICMA), this guide emphasizes planning and implementation issues associated with digital imaging projects. Also addressed are policy and legal issues including records retention, ownership and control of images, and public access.

Technical Advisory Services for Images (TASI)
www.tasi.ac.uk

This website by Technical Advisory Services for Images (TASI), based at the University of Bristol's Institute for Learning and Research Technology (ILRT), provides information for creating and using digital image archives. The site features technical and project management advice, and a glossary of digital imaging terms.